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City of Amesbury IT Assessment and Technology Roadmap

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Contents

Introduction

This document is an informal IT audit created for the City of Amesbury. This audit encompasses municipal, public safety and school related computing resources.

These resources include all of those that make up a modern IT infrastructure:

a) Wide area network - used to connect geographically separated buildings.
b) Local networks - resources that provide building wide network access.
c) Wireless network - support for portable computing devices.
d) Internet access.
e) Server hardware, virtualization and virtual servers.
f) Storage devices and backup mechanisms.
g) Security, data protection and security-related software and strategies.
h) Workstations.
i) Email support.

We will provide a brief overview of the state of each of these categories, an inventory of current resources, and a roadmap for future improvements.

We have spent a fair amount of time collecting live data from the city's various network and computing resources and have taken the current state as a starting point for our recommendations.

We would also like to point out that we are not professional writers. This will probably become apparent as you read through this report. The people responsible for writing this report are computing professionals that install and support the type of resources being audited. We also started this report with an empty word document. This report was written specifically for the City of Amesbury. All errors, whether they be logical, spelling or grammatical were carefully handcrafted and are not the product of cutting and pasting or globally replacing an existing document.

IT Resource Locations

For the context of this report, IT Resource Locations are considered locations that contain servers and server related hardware (e.g. storage devices).

Currently, the city's major IT resource center is located at the Amesbury High School.

Until 2009, the majority of the servers that served the municipal offices were housed at the city hall. They were located in a second floor office. There were no special environmental or power equipment in place and as the number of required servers increased, the amount of noise and heat they generated became an issue, especially for the people working in that office.

The high school renovation, completed in 2008, contained a modern and large server room. It had excess space, environmental controls and power/generator capacity over and above that required to support the high school it resources. A decision was made in 2009 to relocate a number of the municipal servers to the high school's data center. The connection between city hall and the high school was deemed to have sufficient bandwidth (1GB) and reliability (fiber). There is a group of six Hyper-V hosts, configured as a Hyper-V failover cluster currently located at the high school. We will outline the structure and functionality of these servers in a future section. These host most of the municipal related servers.

During this migration, a small server was purchased and located at city hall. This standalone Hyper-V server provides mission critical functionality in the event that the connection to the high school is disrupted. (At that time, a slow backup circuit would provide an emergency VPN connection if required.)

Each school has a small number of servers that provide local resources. There are domain controllers, DHCP servers, file servers and application servers located at each school. There are also a number of older, legacy servers at each location. In 2011, a small server was purchased for each school. Each of these servers was configured with Hyper-V virtualization. New virtual domain controllers and file servers were brought up at the middle and elementary schools as well as the central office (which has since been relocated to the high school.) This new server at the high school provides an additional domain controller for each school domain (see Active Directory Structure for more information.)

Amesbury High School

The datacenter at Amesbury High School is the largest in the city. It's the only purpose built datacenter and was completed in 2008. It houses the IT resources for the high school as well as a large number of the municipal resources.

The network within the high school is segmented into a number of virtual networks (VLANs). These isolate the network traffic and allow for independent routed subnets. There are VLANs for the municipal resources, the central office resources and the high school resources.

High School Resources

There were five servers deployed within the high school datacenter at the end of the renovation project in 2008. These servers are still in place, relatively unchanged. They are fully physical (no virtualization). There are two domain controllers (AHS10, AHS11), an application server (AHSAPPS) and two file servers

(AHSSTUDENT, AHSSTAFF). All but AHS10 is running Windows Server 2003 R2. AHS10 was upgraded to Windows 2008 R2 as part of the 2011 virtualization project.

As part of the 2011 virtualization project, a small server with Hyper-V server was added at the high school. This server hosts a domain controller for each school domain (AHS, AES, CES, AMS) (see Active Directory section for more details) and the central office.

As mentioned above in 2009 most of servers were moved from city hall to the high school datacenter.

Some servers were moved intact and unmodified (AGR1). Some were replaced with newer virtual servers (AGR2, AGR3, THC3, and THCFS) and upgraded, yielding virtual servers.

Two newer servers and a highly reliable storage array were added and a six server Hyper-V cluster was built. This cluster allows for automatic failover of virtual server from one cluster host to another in the case of hardware failure. Virtual servers can also be "migrated" in real-time, without interruption. This aids in performing windows updates on the hosts and also allows load balancing of virtual servers between hosts.

Recommendations

As mentioned above, the "data center" for city hall was created in the original office that housed the IT staff. It grew as the needs of the city grew, with most of its servers moved to the high school in 2009. A single server was put into service at that time to handle network functions and file sharing. The Internet connection, firewalls, WAN router and city hall switches are also contained in this 2nd floor office. This equipment is mission critical.

We would recommend that a climate-controlled area be set up somewhere in city hall to house this equipment and that as much of the hardware currently in that office be relocated to this new area. At a minimum the WAN and firewall hardware should be relocated. We would probably leave the local building network drops and associated edge switches in place as the cost of rewiring these existing connections isn't cost effective and these connections aren't mission critical.

This new area could also be used as a second location for data backup, providing some geographical separation from the data and backups currently contained only at the high school.

The small city hall based server is currently providing network services for police, fire, city hall and Ordway. Its failure could cause significant network disruption.

The newer versions of Windows Server (2012 and 2016) support redundant network management applications. We would recommend that two new Hyper-V hosts be installed at city hall with two virtual domain controllers configured to provide these network services.

A new server should also be located at the police department to support public service functions.

Internet

There are currently two connections to the Internet terminating at city hall. One is a fiber connection provided by Comcast. (This connection is independent of the WAN fiber network they provide the city.) The bandwidth of this connection is 200MB download and 200MB upload. There is also a Verizon DSL circuit that provides 7mb download and 768kb download. This slower connection will be used as a failover should the primary Comcast connection be down.

A pair of Sophos SG430 firewalls are used as the interface to the internet. These two firewalls are set up as a high-availability pair in an active/passive cluster. This device provides address translation, security, content filtering, anti-virus filtering and SPAM filtering It also acts as a wireless controller for a small number of access points located throughout the city.

All fiber-connected facilities share this internet connection. (Sites connected via Sophos RED VPN devices have local internet connections.)

The Comcast fiber connection will be upgraded to a 500MB download and 500MB upload connection in August 2017.

Recommendations

With the coming upgrade, the provided internet bandwidth will be more than sufficient for the needs of the city and the schools. The firewalls are also well matched to the new connection and have enough headroom to support even faster future connections. The costs of internet bandwidth are decreasing rapidly and we are seeing many 1GB Comcast connections being installed in many locations.

As more resources move to the cloud, the internet connection is becoming a mission critical IT component. School testing, police and fire and general city applications will all require internet access going forward.

Having the clustered firewalls eliminates a single point of failure. Having a backup internet connection allows for continued access even with the failure of the primary connection. (Albeit a much slower connection).

The only recommendation we would make in this area is a possible change in the secondary internet connection. The physical wiring for the secondary DSL connection is carried on the same telephone poles as the primary fiber connection. A vehicle striking one of these poles would probably disable both of these connections for an unacceptable time period.

Companies are now producing small routers with built in 4G cellular modems. The speeds of these connections easily exceed DSL speeds and are very reliable. The testing we have done with AT&T as the carrier have yielded speeds as high as 50MB download and 10MB upload.

With the explosion in the number of internet enabled portable devices, phones and tablets, the cost of wireless 4G internet access has declined. This modem uses the same 4G networks. Both Verizon and AT&T have special plans specifically targeted for internet backup connections. AT&T plans start at $30 per month, with caps on the total possible monthly charges, currently $129. There is also a one-time cost of approximately $800 for the hardware (router).

This solution has three advantages to the current DSL connection:

1) It has a lower recurring cost
2) It doesn't share any physical path with the Comcast connection
3) It is faster than DSL.
4) In the case of a disaster, the wireless router can be relocated anywhere within the city.
5) There is no lead time for installation. Like a cell phone, it just needs to be activated on the 4G network.

Wide Area Network

A fiber network interconnects most municipal buildings and all schools. This fiber is provided by Comcast and is dedicated to Amesbury's wire area network. The topology is a star network with the local Comcast facility as the hub. All hardware used to provide network connectivity is provided by the city, the fiber is "dark" and there is no connection the Comcast's network.

The locations interconnected using this network are:

0) Comcast Head End – Clinton Street
1) City Hall – 62 Friend Street
2) Senior Community Center – 68 Elm Street
3) Water Department – 12 Newton Road
4) Amesbury High School – 5 Highland Street
5) Amesbury Middle School – 220 Main Street
6) Amesbury Elementary School – 20 South Hampton Road
7) Cashman Elementary School – 193 Lions Mouth Road

An upgrade was done in 2017 that replaced all fiber connected WAN network hardware in each of these locations.

A Hewlett Packard Enterprise Procurve/Aruba 3810M switch was deployed at the Comcast head-end. It supports most Layer 3 routing protocols.

The 3810M switch can route and switch at a rate of 480Gbps with extremely low latency. It provides 16 SFP+ ports each capable of supporting wire speed 10GB connections. 7 of these fiber connections are currently being utilized. Each of the 7 fiber connections are supported using a 10GB LR optic, providing a full 10GB backbone throughout the city. Since the current network maximum bandwidth is 70Gbps, this switch should be sufficient for any future upgrades. With additional modules, it will also support up to 2 40GB fiber connections. At a point where this technology is cost-effective, two locations could be upgraded, possibly to provide higher speed interconnections between two data centers (e.g. AHS and city hall).

The switch also is equipped with dual/redundant power supplies for increased reliability.

Each remote location is equipped with a Hewlett Packard Enterprise Procurve/Aruba 2920 switch. This switch also supports most Layer 3 routing protocols.

The 2910 switch can route and switch at a rate of 128Gbps. It provides 24 gigabit copper ports and, as configured, 2 10GB SFP+ ports. (It can support up to 4 10GB ports). These switches will be used only to provide access to the network backbone for the local network, so they will provide sufficient overall bandwidth.

The Police Department, located at 19 School Street, and the Fire Department, located at 17 School Street are connected directly to the City Hall network via dedicated (local) 1GB copper and fiber connections.

Four locations are connected using a Sophos RED Virtual Private Network device via a Business Class Comcast cable modem:

1) Waste Water Treatment Plant - 19 Merrimac St
2) DPW Admin Building - 39 South Hunt Road
3) Amesbury Innovation High School – 71 Friend Street

Each of these locations has a local Comcast Business Class modem that provides internet connectivity as well as VPN connectivity to city hall.

Recommendations

The updated WAN is state of the art and provides more than sufficient bandwidth to support all network related functions.

Considering that the WAN is structured as a star, with the Comcast headend as the hub, we would recommend the purchase of a spare core fiber routing switch (HP 3810M) with a single spare power supply.

We would also recommend purchasing a spare remote building router (HP 2920) as well as a spare 10GB LR Optic.

Given this set of spares, any failure in a WAN component could be quickly remediated.

WAN Subnet Summary

10.128.0.0/16	City Hall 10G BB	10.10.10.128
10.129.0.0/16	AMS	10.10.10.6
10.130.0.0/16	CES	10.10.10.4
10.131.0.0/16	AES	10.10.10.5
10.132.0.0/16	WTP	10.10.10.10
10.133.0.0/16	Central (at AHS)	10.10.10.2
10.134.0.0/16	AHS	10.10.10.2
10.135.0.0/16	Senior Center	10.10.10.8
172.16.1.0/24	DPW Admin (via RED VPN)	172.16.1.1
172.16.2.0/24	Waterwater TP (via RED VPN)	172.16.2.1
172.16.5.0/24	AIHS (via RED VPN)	172.16.5.1

Local Networks

There are multi-switch local area networks in city hall, AHS, AES, CES and AMS.

We will give an overview and provide recommendations for each location.

City Hall

The city hall LAN services city hall, the police department, the fire department and the Ordway Building.

There is a new 10GB routing switch that provides connectivity to the WAN (HP 2920-24G), a local router (HP 3500yl-24G) and two edge switches (HP 2848, HP 2920-48G) that service the required network connections in city hall. The internet connection is carried by this switch to the Comcast core and to all other fiber connected locations.

There is a copper connection between the local city hall router and the four police department switches. This is a 1GB connection. Two of the PD switches (HP 292048G POE+, HP 2530-8G POE+) provide power usable by access points and phones. There are also two edge switches (HP 2524, HP 2824). Three of these switches are 1GB capable and one is only 100M capable.

The connection to the fire department is via the PD HP 2824 switch and utilizes multi-mode fiber running at 1GB. There is a single switch (HP 2810-24G) in the fire department LAN. The Ordway Building is connected to this switch via another multi-mode fiber running at 1GB. (HP 2626). The 2810-24G is a gigabit capable switch while the 2626 is only 100MB capable.

Since this building provides the internet connection for all other locations, a redundant power supply should probably be deployed for the WAN router or a spare 2920-24G could be acquired. This spare could also be used to quickly replace any WAN router in any building.

We would suggest upgrading the two 100MB switches to 1GB switches. It would probably make sense to give the FD a new POE switch and repurpose the 1G switch already in place.

The connection to PD is currently servicing the PD, FD and Ordway. We would recommend using a 10GB fiber connection to PD, or at least aggregating multiple 1G connections. (This could be done in conjunction with the creation of a data center at city hall (see IT Locations)). One could also consider upgrading the PD to FD link to 10Gb as well. The existing fiber can reliably support 10GB connections up to 700 ft.

Amesbury High School (AHS)

The high school network was replaced during the 2008 building rehabilitation project. It was designed to carry video data over the network, and at that time high bandwidth support was required. There is a new 10GB routing switch that connects to the WAN (HP 2920-24G). The local router core is a high speed HP Chassis switch (HP5412zl). There are 7 other data locations within the building. Each of these is connected back to the local core with a 10GB fiber connection. Each closet has between 48 and 96 1GB copper connections. A 48 port POE+ switch was recently added to most closets to provide extra connections as well as provide power to the Aerohive wireless access points that were used to upgrade the original HP wireless. There are a total of 912 1G copper ports within the high school.

There is an HP 3500-24G that provides WAN connectivity and routing for the high school and the Central Office (which is located in the high school).

The AHS network is still state of the art, and we don't recommend any changes.

Amesbury Middle School

The middle school is the second largest LAN with 264 copper ports. There is a new 10GB routing switch that connects to the WAN (HP 2920-24G). There are two 48 port 1GB capable POE+ switches (Brocade ICX6450-48P), 2 Netgear 24 port 1GB capable switches (Netgear GS724T), 3 HP 24 port 1GB capable switches (HP 2524-24G), and one HP 24 port 1GB capable switch (HP 2810-24G).

The middle school network is fully 1GB capable, with 1GB backbone connections, and is probably sufficient. The Netgear switches don't provide full management capabilities and wouldn't work with most network-wide management tools, but are good switches nevertheless.

Cashman Elementary School

Cashman has a network consisting of 216 ports. There is a new 10GB routing switch that connects to the WAN (HP 2920-24G). There are six Allied Telesis 24 port 1GB capable switches (five AT-9000/24, one AT-8624T), two HP 1GB capable switches (HP 2848 and HP 2900-24G).

The middle school network is fully 1GB capable, with 1GB backbone connections, and is probably sufficient.

Amesbury Elementary School

Amesbury Elementary has a network consisting of 170 ports. There is a new 10GB routing switch that connects to the WAN (HP 2920-24G). There are 3 24 port 1GB capable HP switches (HP 2524-24G), one 100MB capable HP switch (HP 2626), one Netgear 1GB capable switch (Netgear GS724T) and one Allied Telesis 24 port 1GB capable switch (AT-8624T).

We would recommend the replacement of the HP 2626, 100MB switch, and other than the Netgear issue noted above, this network is probably sufficient.

General School LAN Recommendations

There is a discussion in the wireless section about providing more coverage and capacity within the schools. If a project of this nature is undertaken, an upgrade to each LAN will also be required. There will probably have to be more ports provided for network connections as well as to provide power for the wireless access points.

Depending on the number of access points installed, faster internetwork backbone connections might also be desirable. Any required switches, wiring, fiber connections and associated installation is eligible for ERate discounts as outlined in the wireless section. Any plans to install additional wireless using these funds should also include an upgrade to the LAN switches.

Municipal Building LAN Summary

Function	IP	Model	Comment
WAN Router (10GB)	10.10.10.128	HP 2920-24G	
Local Router	10.128.0.253	HP 3500yl-24G	
City Hall Edge	10.128.0.241	HP 2848	
City Hall Edge	10.128.0.239	HP 2920-48G	
PD Core	10.128.0.248	HP 2920-48G POE+	
PD Edge Switch	170.154.131.237	HP 2524	
PD POE Edge Switch	10.128.7.43	HP 2530-8G POE+	
PD Edge Switch	10.128.0.243	HP 2848	SX fiber link to FD
FD Edge Switch	10.128.0.244	HP 2810-24G	SX fiber link to PD
Ordway Edge	10.128.0.245	HP 2626	SX fiber link to Ordway

Amesbury Public School LAN Summary

Brand	Model	Location	IP	Switch Type	Ports
HP Switch	2524-24G	AES	10.131.0.251	Edge	24
HP Switch	2524-24G	AMS	10.131.0.252	Edge	24
HP Switch	2524-24G	AMS	10.131.0.253	Edge	24
HP Pro Curve	2626	AES	10.131.0.250	Edge	26
Netgear Prosafe	GS724T	AES	10.131.0.248	Edge	24
Allied Telesis	AT-8624T/2M	AES	10.131.0.254	School WAN Router	24
HP	2920-24G	AES	10.10.10.131	10G WAN Backbone Router	24
				Total ports	170

Cashman Elementary School LAN Summary

Brand	Model	Location	IP	Switch Type	Ports
HP Switch	2524-24G	AES	10.131.0.251	Edge	24
HP Switch	2524-24G	AMS	10.131.0.252	Edge	24
HP Switch	2524-24G	AMS	10.131.0.253	Edge	24
HP Pro Curve	2626	AES	10.131.0.250	Edge	26
Netgear Prosafe	GS724T	AES	10.131.0.248	Edge	24
Allied Telesis	AT-8624T/2M	AES	10.131.0.254	School WAN Router	24
Aruba	2920-24G	AES	10.10.10.131	10G WAN Backbone Router	24
				Total ports	170

Amesbury Middle School LAN Summary

Brand	Model	Location	IP	Switch Type	Ports
Brocade	ICX6450-48P	AMS	10.129.0.6	Edge POE	48
HP Switch	2810-24G	AMS	10.129.0.7	Edge	24
Netgear	GS724T	AMS	10.131.0.4	Edge	24
Netgear	GS724T	AMS	10.131.0.5	Edge	24
HP Switch	2524-24G	AMS	10.131.0.251	Edge	24
HP Switch	2524-24G	AMS	10.131.0.252	Edge	24
HP Switch	2524-24G	AMS	10.131.0.253	Edge	24
Brocade	ICX6450-48P	AMS	10.129.0.254	School WAN Router	48
HP	2920-24G	AMS	10.10.10.131	10G WAN Backbone Router	24
				Total ports	264

Amesbury High School LAN Summary

Brand	Model	Location	IP	Switch Type	Ports	MDF/IDF Location	Comment
HP	E5412zl	AHS	10.134.0.200	School Core	168	MDF	
HP	2900-48G	AHS	10.134.0.202	Edge	48	IDF RM 234	10G uplink to core
HP	2900-48G	AHS	10.134.0.203	Edge	48	IDF Outside Aud	10G uplink to core
HP	2900-48G	AHS	10.134.0.208	Edge	48	IDF Outside Aud	10G uplink to above
Brocade	ICX6450-48P	AHS	10.134.0.213	Edge POE	48	IDF Outside Aud	
HP	2900-48G	AHS	10.134.0.204	Edge	48	IDF RM 126	10G uplink to core
Brocade	ICX6450-48P	AHS	10.134.0.215	Edge POE	48	IDF RM 126	10G uplink to above
HP	2900-48G	AHS	10.134.0.206	Edge	48	IDF Hoyt	10G uplink to core
HP	2900-48G	AHS	10.134.0.205	Edge	48	IDF Hoyt	10G uplink to above
Brocade	ICX6450-48P	AHS	10.134.0.216	Edge POE	48	IDF Hoyt	
HP	2900-24G	AHS	10.134.0.207	Edge	24	IDF RM112	10G uplink to core
HP	2900-48G	AHS	10.134.0.211	Edge	48	IDF RM112	10G uplink to above
Brocade	ICX6450-48P	AHS	10.134.0.214	Edge POE	48	IDF RM112	
HP	2900-48G	AHS	10.134.0.209	Edge	48	IDF Main Office	10G uplink to core
HP	2900-48G	AHS	10.134.0.210	Edge	48	IDF RM226	10G uplink to core
Brocade	ICX6450-48P	AHS	10.134.0.212	Edge POE	48	MDF	
HP	3500-24G	AHS	10.134.0.254	School WAN Router	24	MDF	
HP	2920-24G	AHS	10.10.10.134	Backbone Router	24	MDF	
				Total ports	912		

Wireless

With the explosion in the type and number of connected portable devices, providing wireless access has become mandatory.

There are currently two wireless systems in use within the municipal buildings and schools.

During the high school renovation HP access points were deployed and provided full building coverage. These access points supported the 802.11a/b/g protocols at 2.4 GHz which had a maximum bandwidth of 56MB/s. These access points didn't support the newer, faster wireless protocols.

The Sophos firewall at city hall has the capability to act as a wireless controller. 21 Sophos access points were initially deployed to provide a baseline of coverage at city hall and each of the schools (other than the high school). There were two models of Sophos Aps used. The AP50, which supports both 2.4 GHz and 5Ghz frequencies as well as 802.11a/b/g/n protocols with speeds up to 300MB/s, and the AP100 which supports both 2.4Ghz and 5Ghz frequencies as well as 802.11a/b/g/n/ac protocols with speeds up to 1.3GB/s.

When the high school wireless was upgraded, it was decided to use Aerohive products. These were a new style of wireless products that were managed from Aerohive owned servers based in the cloud. Management is consolidated for all sites and products and can be performed from any location with internet access. The access point used is the Aerohive AP230 which supports both 2.4 GHz and 5 GHz frequencies as well as 802.11a/b/g/n/ac protocols with speeds up to 1.3GB/s.

The Aerohive access points were deployed in the high school (25), city hall (1) and the middle school (19).

Sophos access points are still currently deployed at AIHS (2), Amesbury Elementary (2) and Cashman Elementary (2).

Recommendations

In the city's environment, the cloud based management model of the Aerohive is optimal. We would recommend the continued expansion of the wireless networks using only their products.

The wireless networks in both elementary schools obviously need to be expanded to provide increased coverage. Also, with more student devices being deployed as well as "bring-your-own-device" scenarios increasing, capacity is also a consideration. Many of our wireless deployments in schools are now approaching an access point per classroom.

Increased coverage and capacity is also desirable in the municipal buildings as well.

Funding for the school's wireless and network infrastructure is available for schools via the ERate program. This program effectively provides wireless hardware, network wiring and network switches at a discounted rate. The amount available is computed on a per school building basis and depends on the number of students on a five-year cycle.

The city would have to budget the post discount amount, but this is still an economical solution, and should be exploited.

Wireless Access Point Summary AHS

Location	Host Name	MAC	Serial #	Manufacturer	Model	Total APS in location
AHS	HS-Auditorium	D854A26E2280	2301511132127	Aerohive	AP230	25
AHS	HS-DanceStudio	D854A243DD00	2301509300072	Aerohive	AP230	
AHS	HS-Guidance	D854A26E2740	2301511132146	Aerohive	AP230	
AHS	HS-Gym	D854A243E680	2301509300110	Aerohive	AP230	
AHS	HS-Library1	D854A26E1EC0	2301511132112	Aerohive	AP230	
AHS	HS-Library2	D854A26E2F80	2301511132179	Aerohive	AP230	
AHS	HS-Main Office	D854A243FE00	2301509300204	Aerohive	AP230	
AHS	HS-OutsideBaths	D854A24B87C0	2301510133065	Aerohive	AP230	
AHS	HS-Rm102	D854A24B2380	2301510132664	Aerohive	AP230	
AHS	HS-Rm106	D854A24B3A00	2301510132754	Aerohive	AP230	
AHS	HS-Rm108	D854A24B1F40	2301510132647	Aerohive	AP230	
AHS	HS-Rm110	D854A24B1F00	2301510132646	Aerohive	AP230	
AHS	HS-Rm114	D854A243DD80	2301509300074	Aerohive	AP230	
AHS	HS-Rm117	D854A243DF80	2301509300082	Aerohive	AP230	
AHS	HS-Rm123	D854A243DF40	2301509300081	Aerohive	AP230	
AHS	HS-Rm124	D854A243DEC0	2301509300079	Aerohive	AP230	
AHS	HS-Rm127	D854A243DF00	2301509300080	Aerohive	AP230	
AHS	HS-Rm132	D854A2446880	2301509300630	Aerohive	AP230	
AHS	HS-Rm138	D854A243F800	2301509300180	Aerohive	AP230	
AHS	HS-Rm222	D854A24B1DC0	2301510132641	Aerohive	AP230	
AHS	HS-Rm230	D854A24B8140	2301510133039	Aerohive	AP230	
AHS	HS-Rm233	D854A24B2080	2301510132652	Aerohive	AP230	
AHS	Hs-Rm238	D854A24B2900	2301510132686	Aerohive	AP230	
AHS	HS-Rm239	D854A24B8340	2301510133047	Aerohive	AP230	
AHS	HS-Rm244	D854A24B6BC0	2301510132953	Aerohive	AP230	

Wireless Access Point Summary AMS

Location	Host Name	MAC	Serial #	Manufacturer	Model	Total APS in location
AMS	MS-Auditorium	D854A24B1E40	2301510132643	Aerohive	AP230	19
AMS	MS-GirlslockerRoom	D854A26EA040	2301511132630	Aerohive	AP230	
AMS	MS-Hallway100-101	D854A24B9340	2301510133111	Aerohive	AP230	
AMS	MS-HallwayRm104-105	D854A24B1E80	2301510132644	Aerohive	AP230	
AMS	MS-HallwayRM111	D854A24B6940	2301510132943	Aerohive	AP230	
AMS	MS-HallwayRm200-201	D854A24B2A00	2301510132690	Aerohive	AP230	
AMS	MS-HallwayRM207	D854A24B2C80	2301510132700	Aerohive	AP230	
AMS	MS-HallwayRM302	D854A24B2E80	2301510132708	Aerohive	AP230	
AMS	MS-HallwayRM306	D854A24B2AC0	2301510132693	Aerohive	AP230	
AMS	MS-HallwayRM401	D854A24B2880	2301510132684	Aerohive	AP230	
AMS	MS-HallwayRM407	D854A24B2800	2301510132682	Aerohive	AP230	
AMS	MS-MediaCtr	D854A24B2F00	2301510132710	Aerohive	AP230	
AMS	MS-Rm116	D854A24B2A40	2301510132691	Aerohive	AP230	
AMS	MS-Rm120	D854A24B2700	2301510132678	Aerohive	AP230	
AMS	MS-Rm213	D854A24B2BC0	2301510132697	Aerohive	AP230	
AMS	MS-Rm220	D854A24B2D80	2301510132704	Aerohive	AP230	
AMS	MS-VP-Office	D854A26E2500	2301511132137	Aerohive	AP230	
AMS	MS-WeatherStation	D854A26EA280	2301511132639	Aerohive	AP230	
AMS	AMS-Lobby-Closet	D854A26E20C0	2301511132120	Aerohive	AP230	

Wireless Access Point Summary City Hall, AIHS, CES, AES

Location	Host Name	MAC	Serial #	Manufacturer	Model	Total APS in location
City Hall	CityHall_2ndFloor	D854A26E25C0	2301511132140	Aerohive	AP230	1
AIHS		001A8C8253C0	A40026741361EE7	Sophos	AP100	2
AIHS		001A8C8253C0	A40026741361EE7	Sophos	AP100	
AES		001A8C73F21F	A40018650D74A1B	Sophos	AP100	3
AES		001A8C73F21D	A40018A6061A0D0	Sophos	AP50	
AES		001A8C73F21C	A4001879D5CDCAE	Sophos	AP50	
AES						
CES		001A8C8224FD	A40026A58FDC48A	Sophos	AP100	3
CES		001A8C73F1C8	A40018DFF2E0291	Sophos	AP50	
CES		001A8C7CF1D1	A40021148458C1F	Sophos	AP50	

Active Directory

Active Directory is the directory service used by Microsoft in conjunction with Windows servers running in a domain environment. Active Directory is hierarchical or tree-structured. The entire hierarchy is called a “forest”. A forest can contain one or more domains.

Active Directory is basically a database of objects defined within a set of domains. A domain is a collection of computers, users, groups and other related objects.

Active Directory also contains information related to security both within a domain and between domains within a forest. One domain can trust another, granting users from another domain access to its resources.

Domains are normally set up to provide consistent security policies and separation. For example, in a school environment, there might be a student domain, a teacher domain and an administration domain. Normally it is best to keep the domain structure as simple as possible while still providing adequate security and separation.

The domain structure in the Amesbury forest is simple, there is a root domain called “AMESBURYGOV” or “AMEBURYGOV.COM”.

Below the root domain, there are seven subdomains:

1) AMESBURY (general municipal) or thc.amesburygov.com
2) APS (public safety) or aps.amesburygov.com
3) CENTRAL (central office) or central. amesburygov.com
4) AHS (Amesbury High School) or ahs.amesburygov.com
5) AMS (Amesbury Middle School) or ams.amesburygov.com
6) AES (Amesbury Elementary School) or aes.amesburygov.com
7) CES (Cashman Elementary School) or ces.amesburygov.com

Recommendations

When the school domains were set up, a decision was made to create a separate domain for each school. Besides making navigating the school resources inconvenient, having separate domains requires separate domain controllers for each of these domains.

It would certainly make sense to fold all school domains into a single domain. Extra domain controllers, including those running on older hardware, could be retired. Newly purchased school devices could be joined to this new domain, and older devices could be optionally moved as well.

Having a single school domain would simplify resource sharing and improve security mechanism. A separate domain for administration and staff could also be considered.

Server Virtualization

Server Virtualization allows the creation and execution of multiple “virtual” servers on a single physical server.

An operating system provides an abstraction of a “process”. Consider a program run by a user as a process. On modern operating systems, a user can run multiple simultaneous programs on a single computer. Each program “thinks” it has exclusive use of the computer’s resources while its running. The execution of these processes is mediated by a “scheduler”. When one process is waiting for keyboard input, and cannot run it will be dismissed and another process will be run. The scheduler also enforces fairness and priority. It will keep one program from monopolizing the processor and provide priority to important processes. Thus effective use will be made of the computer’s resources between all of the running processes.

Server virtualization is similar, but instead of processes, one has virtual servers. The virtual server is basically a set of files on the physical server that contains state information. In this model, the “hypervisor” is the scheduler that mediates the allocation of resources to the virtual servers. There are a number of “hypervisors” in the market today, Linux-based open source (Xen), Linux-based commercial (VMWare) and Windows-based commercial (Microsoft Hyper-V). When virtualization was implemented in Amesbury a decision was made to utilize the Microsoft hypervisor, Hyper-V. There were three factors that influenced this decision. One was cost; Hyper-V was included at no extra cost in the Windows 2008 server operating system (it is also included free of charge in all newer version of Windows). Secondly, since Hyper-V uses existing Windows interfaces, required training is minimal. Many of the skills needed to operate and maintain Hyper-V virtual servers are already familiar to Windows users. Lastly, a decision was made that by utilizing a Hyper-V failover cluster, there would be sufficient reliability and robustness.

In 2009 a decision was made to relocate a number of servers from city hall to the high school. At that time two new servers and a storage array was purchased. A migration process known as “physical to virtual” was used to convert 4 existing physical servers into 4 virtual servers and they were deployed on the two new servers. Those four legacy physical servers then underwent minor upgrades that allowed them to also be used for virtualization. Along with the storage array, a six node Hyper-V failover cluster was created.

Hyper-V supports a high-availability mechanism called “clustering”. By using a shared storage devices two or more Hyper-V servers can “share” virtual machines. Clustering provides the following features:

1) Virtual machines can be moved in real-time without interruption between clustered servers. (With some limitations. These moves must be from servers with similar hardware. In the case of your clusters that would be only between THCVS1 and THCVS2, THCVS3 and THCVS4 and THCVS5 and THCVS6.)
2) If a Hyper-V host in the cluster fails, the virtual machines it is hosting will automatically move to another compatible host on the cluster without interruption.
3) Hyper-V hosts can be updated without interruption. The virtual servers that it hosts can be moved to another cluster member, the host updated and rebooted if needed. After the update

is complete, the hosts can be moved back to the original host. This can be done for all members of the cluster.

Setting up clustering correctly is a somewhat complex task. To provide full high-availability there must be no single point of failure. The storage array must have fill redundancy, hard drives, power supplies and controllers. Hard drive redundancy can be accomplished using RAID technology, which is supported by all storage arrays. Storage arrays that support dual controllers are much harder to engineer than those that only have a single controller. The hard drives that support this type of access are also more complex and normally must be fully tested for compatibility with the storage arrays. Both of these requirements increase the cost of these storage arrays considerably.

The servers must also have redundancy. Hard drives that contain the operating systems files should use RAID technology and there should be dual power supplies. There also has to be dual paths between the servers and the storage arrays (one to each controller). These connections are implemented using either storage controllers within the server or by using standard network connections. The storage controller solution would add to the cost of the server and the network solution would require dedicated network switches, adding to the overall solution cost. (The cluster at AHS is using the network connection solution and there are two dedicated Ethernet switches to support the six servers and two cluster related storage arrays.)

There is also a fair amount of configuration that must be done to set up the cluster within the Windows environment. This setup must be done within the active directory environment and then on each cluster member server.

Between the storage arrays, the servers and the storage switches, there is a fair amount of complexity to support the clustering solution. Clustering also relies heavily on active directory. All of these mechanisms must be working properly for clustering to work. It is said Windows Hyper-V clustering has a lot of “moving parts”. Failure of one of these parts can impact the cluster significantly. Without an available domain controller, the cluster will not start, and its servers will be unavailable. (One would be unwise to locate all of their domain controllers in a cluster (see chicken/egg)). Also, without a properly operating cluster the virtual machines stored on the storage array within the cluster storage areas will be inaccessible. This can make disaster recover more of a disaster. Non-functional cluster hosts can end up in a state where they retain ownership of their virtual servers, but these virtual servers are not running. None of these things happen on a properly running cluster, and they are normally quite reliable. But one might ask why there are so many possible issues that can cause a highly-reliable solution to fail and why one use would this mechanism. The answer to the latter is that it was the only mechanism available for Hyper-V high availability before Windows 2012. The answer to the former is that Microsoft always tries to layer existing technologies to create their solutions and this sometimes complicates their technologies. Often with Microsoft the cure is worse than the disease. (See below for Microsoft’s updated high(ish) availability mechanisms.

A small Hyper-V server was also set up at City Hall. It hosted a domain controller that provided local network resources as well as a local file server. There was also a small local storage array that provided a second, local, backup of important data that was primarily housed at the high school. (This array has since been retired.)

In 2011 a small Hyper-V host was purchased for each school and the central office. These servers were used to provide an updated domain controller, file server and application server at each location.

Recommendations

We would recommend that the city continue to use Microsoft Hyper-V. It would make no sense to go through the expense of purchasing another product and converting the existing virtual machines. Other solutions would also require extensive training for any support staff, or endless consulting fees.

When new Hyper-V servers are deployed they will be using Windows 2012R2 or Windows 2016. Both of these versions provide significant improvements over the currently deployed Windows 2008R2.

With Hyper-V 2008R2 clustering was the preferred mechanism for providing high availability. A shared storage array was required; normally dual controllers were used to provide high reliability. This was usually an expensive device (see above).

With Hyper-V 2012R2 and Hyper-V 2016 there are new features that provide most of the functionality proviced by a cluster without the need for an expensive storage array or the complexity of clustering:

1) Virtual machines can be replicated between hosts without any special hardware. The replica can be updated in near-real time. Historical replicas can also be stored. The main difference between a replica and a fail-over cluster virtual machine is that in a cluster failover is automatic (hopefully) where in the replication scenario the replica must be manually started if the main server fails.
2) Live migrations of virtual machines can be performed between similar hosts without the need for shared storage.
3) Virtual Hyper-V networks can be used to allow the execution of servers that are replicated to different subnets. This allows replication to remote location allowing “stand-by” backup datacenters. This is a very new and powerful feature that could be used if a new data center is created at city hall. This would allow servers to be replicated between the high school and city hall, and run at either location if one data center is unavailable.

Our recommendation would be to use these new features and migrate away from Hyper-V clustering. This will bring down costs and decrease overall complexity. All existing virtual servers are compatible with the new version of Hyper-V. Migrating a virtual server is as easy as copying a file to the new host and doing a simple Hyper-V import operation.

Servers

We inventoried 26 physical servers. 11 of these servers are municipal-related and the other 15 are school related.

12 of the servers are Hyper-V virtualization hosts. There are 6 physical domain controllers, 3 file servers, 3 application server and 2 video servers.

The age of the newest server is 6 years, the oldest is 13.5 years. 2 of the Hyper-V hosts are 9 years old and the balance are less than 7 years old, with the newest being 6.5 years old.

This is the breakdown of the operating systems deployed on these servers:

1) Windows 2003 – 6
2) Windows 2003R2 – 6
3) Windows 2008R2 – 14

There are 41 virtual servers running on the Hyper-V hosts. 3 of these servers are running Windows 2003R2, 1 Windows 2008, 32 Windows 2008R2 and 5 Windows 2012R2. There are 16 virtual domain controllers, 10 virtual file servers, 9 application servers, 2 backup servers, 2 antivirus servers, one Exchange (Email) Server, one licensing server and one Windows Update Server.

Recommendations

The strongest recommendation in this report, besides having good backups, will be this: new servers must be purchased as soon as possible.

Some of the oldest physical servers are primarily domain controllers. Each domain has multiple domain controllers and retiring the older ones is a simple task. (Care must be taken that the server is not also performing other functions. It was not uncommon practice before virtualization to have domain controllers that also act as file servers. If this is the case the domain controller can be demoted and then the server virtualized as a file server.)

There is an older file server at AMS that should either be virtualized or its shares moved to a newer server and it should be retired.

Two of servers that are part of the Hyper-V cluster are 9.4 years old. Any virtual machines running on those servers can be migrated to other cluster members at which time those servers should be removed from the cluster and retired.

The next set of physical server were installed as part of the high school renovation 9 years ago. Each of these server should be virtualized and their corresponding physical hardware should be retired.

After the 6.5-year mark, all servers that were purchased were purpose built Hyper-V hosts. These servers are of high enough quality that they could be used to host non-mission critical virtual servers.

Beyond that, the purchase of new Hyper-V hosts is critical.

Physical Server Hardware Summary

Name	Location	Function	Serial Number	Model	Date of Manufacture	Processors	Memory	Disk	Power Supplies	Form Factor
Patriotserver	ACH	Patriot Personal Property Server	<none>	Dell Poweredge SC1430	7/10/2007	Intel Xeon 5110 1.6GHz	2G	2x80G	Single	Ped
Pontem	ACH	Pontem Cemetary Software	MXL0361PZL	HP Compaq 8000 PC	11/19/2014	Intel Core Duo E8400 3.0Hgz	2G	1x120G	Single	DT
Thcvh1	ACH	Hyper-V Host	H4QC3M1	Dell Poweredge R210	2/22/2010	Intel Xeon X3430 2.4GHz	4G	2x250G	Single	RM
Aes2	AES	Domain Controller AES	BJ08V51	Dell Poweredge 1800	10/21/2004	Intel Xeon 2.8GHz	2G	1x40G	Single	RM
Asdvh2	AES	Hyper-V Host	H44C8P1	Dell Poweredge R210	1/11/2011	Intel Xeon X3430 2.4GHz	8G	2x1TB	Single	RM
Ahs10	AHS	Domain Controller AHS	6TB0VG1	Dell Poweredge 2950	7/17/2008	2xIntel Xeon E5410 2.33GHz	4G	2x250G	Dual	RM
Ahs11	AHS	Domain Controller AHS	7TB0VG1	Dell Poweredge 2950	7/17/2008	2xIntel Xeon E5410 2.33GHz	4G	2x250G	Dual	RM
Ahsapps	AHS	Application Server	8TB0VG1	Dell Poweredge 2950	7/17/2008	2xIntel Xeon E5410 2.33GHz	4G	2x250G	Dual	RM
Ahsstaff	AHS	File Server	5P323H1	Dell Poweredge 2950	8/7/2008	2xIntel Xeon E5410 2.33GHz	4G	4x1TB	Dual	RM
Ahsstudent	AHS	File Server	5P323H1	Dell Poweredge 2950	8/7/2008	2xIntel Xeon E5410 2.33GHz	4G	4x1TB	Dual	RM
Ahsvideo1	AHS	Video Server	9XZ8KH1	Dell Poweredge 1950	10/9/2009	Intel Xeon E5405 2.0GHz	2G	2x146G	Dual	RM
Ahsvideo2	AHS	Video Server	G4YVPH1	Dell Poweredge 1950	11/11/2008	Intel Xeon E5405 2.0GHz	1G	1x300G	Dual	RM

Name	Location	Function	Serial Number	Model	Date of Manufacture	Processors	Memory	Disk	Power Supplies	Form Factor
Asdvh1	AHS	Hyper-V Host	H43F8P1	Dell Poweredge R210	1/11/2011	Intel Xeon X3430 2.4GHz	8G	2x1TB	Single	RM
Agr1	AHS	Domain Controller AMESBURYGOV	367M941	Dell Poweredge 1750	2/1/2004	Intel Xeon 3.06GHz	2G	3x73G	Dual	RM
Thcvs1	AHS	Hyper-V Cluster (Pair 1)	84JLFG1	Dell Poweredge 1950	6/5/2008	Quad Core Intel Xeon 2.33GHz	4G	3x146G	Dual	RM
Thcvs2	AHS	Hyper-V Cluster (Pair 1)	6L90CG1	Dell Poweredge 1950	5/21/2008	Quad Core Intel Xeon 2.33GHz	4G	3x146G	Dual	RM
Thcvs3	AHS	Hyper-V Cluster (Pair 2)	66RP3P1	Dell Poweredge 2970	10/28/2010	AMD Opteron 2374HE 2.2GHz	32GB	2x146G	Dual	RM
Thcvs4	AHS	Hyper-V Cluster (Pair 2)	56RP3P1	Dell Poweredge 2970	10/28/2010	AMD Opteron 2374HE 2.2GHz	32GB	2x146G	Dual	RM
Thcvs5	AHS	Hyper-V Cluster (Pair 3)	8GVL8R1	Dell Poweredge R415	7/14/2011	AMD Opteron 4180 2.6GHz	32GB	2x146G	Dual	RM
Thcvs6	AHS	Hyper-V Cluster (Pair 3)	9GVL8R1	Dell Poweredge R415	7/14/2011	AMD Opteron 4180 2.6GHz	32GB	2x146G	Dual	RM
Ams3	AMS	File Server	18JMZ61	Dell Poweredge 2800	3/14/2008	Intel Xeon 2.8GHz	2G	3x36G	Single	Ped
Asdvh4	AMS	Hyper-V Host	H45C8P1	Dell Poweredge R210	1/11/2011	Intel Xeon X3430 2.4GHz	8G	2x1TB	Single	RM
Aps2	APS	Domain Controller APS/IMC	B0W7Y61	Dell Poweredge 2800	3/11/2008	Intel Xeon 3.2GHz	1G	3x73G	Dual	Ped
Asdvh3	CENTRAL	Hyper-V Host	H44F8P1	Dell Poweredge R210	1/11/2011	Intel Xeon X3430 2.4GHz	8G	2x1TB	Single	RM
Central2	CENTRAL	Domain Controller CENTRAL	DDMNG81	Dell Poweredge 2850	9/12/2005	Intel Xeon 2.8GHz	2G	4x73G	Dual	RM
Asdvh5	CES	Hyper-V Host	H44D8P1	Dell Poweredge R210	1/11/2011	Intel Xeon X3430 2.4GHz	8G	2x1TB	Single	RM

Physical Server Age Summary

Name	Location	Function	Serial Number	Model	Date of Manufacture	Age (years)
Pontem	ACH	Pontem Cemetary Software	MXL0361PZL	HP Compaq 8000 PC	11/19/2014	2.7
Thcvs5	AHS	Hyper-V Cluster (Pair 3)	8GVL8R1	Dell Poweredge R415	7/14/2011	6.0
Thcvs6	AHS	Hyper-V Cluster (Pair 3)	9GVL8R1	Dell Poweredge R415	7/14/2011	6.0
Asdvh2	AES	Hyper-V Host	H44C8P1	Dell Poweredge R210	1/11/2011	6.6
Asdvh1	AHS	Hyper-V Host	H43F8P1	Dell Poweredge R210	1/11/2011	6.6
Asdvh4	AMS	Hyper-V Host	H45C8P1	Dell Poweredge R210	1/11/2011	6.6
Asdvh3	CENTRAL	Hyper-V Host	H44F8P1	Dell Poweredge R210	1/11/2011	6.6
Asdvh5	CES	Hyper-V Host	H44D8P1	Dell Poweredge R210	1/11/2011	6.6
Thcvs3	AHS	Hyper-V Cluster (Pair 2)	66RP3P1	Dell Poweredge 2970	10/28/2010	6.8
Thcvs4	AHS	Hyper-V Cluster (Pair 2)	56RP3P1	Dell Poweredge 2970	10/28/2010	6.8
Thcvh1	ACH	Hyper-V Host	H4QC3M1	Dell Poweredge R210	2/22/2010	7.4
Ahsvideo1	AHS	Video Server	9XZ8KH1	Dell Poweredge 1950	10/9/2009	7.8
Ahsvideo2	AHS	Video Server	G4YVPH1	Dell Poweredge 1950	11/11/2008	8.7
Ahsstaff	AHS	File Server	5P323H1	Dell Poweredge 2950	8/7/2008	9.0
Ahsstudent	AHS	File Server	5P323H1	Dell Poweredge 2950	8/7/2008	9.0
Ahs10	AHS	Domain Controller AHS	6TB0VG1	Dell Poweredge 2950	7/17/2008	9.0
Ahs11	AHS	Domain Controller AHS	7TB0VG1	Dell Poweredge 2950	7/17/2008	9.0
Ahsapps	AHS	Application Server	8TB0VG1	Dell Poweredge 2950	7/17/2008	9.0
Thcvs1	AHS	Hyper-V Cluster (Pair 1)	84JLFG1	Dell Poweredge 1950	6/5/2008	9.2
Thcvs2	AHS	Hyper-V Cluster (Pair 1)	6L90CG1	Dell Poweredge 1950	5/21/2008	9.2
Ams3	AMS	File Server	18JMZ61	Dell Poweredge 2800	3/14/2008	9.4
Aps2	APS	Domain Controller APS/IMC	B0W7Y61	Dell Poweredge 2800	3/11/2008	9.4
Patriotserver	ACH	Patriot Personal Property Server	<none>	Dell Poweredge SC1430	7/10/2007	10.1
Central2	CENTRAL	Domain Controller CENTRAL	DDMNG81	Dell Poweredge 2850	9/12/2005	11.9
Aes2	AES	Domain Controller AES	BJ08V51	Dell Poweredge 1800	10/21/2004	12.8
Agr1	AHS	Domain Controller AMESBURYGOV	367M941	Dell Poweredge 1750	2/1/2004	13.5
					Average age	8.3
					Median age	8.7

Physical Server Domain Summary

Name	Domain	Function	OS Version	Model	BuildDate	IP Address	Age (years)
Asdvh2	AES	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	1/11	10.131.121	6.6
Aes2	AES	Domain Controller AES	Win 2003	Dell Poweredge 1800	10/21	10.131.1.2	12.8
Asdvh1	AHS	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	1/11	10.134.1.20	6.6
Ahsvideo1	AHS	Video Server	Win 2003	Dell Poweredge 1950	10/9	10.134.100	7.8
Ahsvideo2	AHS	Video Server	Win 2003 R2	Dell Poweredge 1950	11/11	10.134.1.10	8.7
Ahsstaff	AHS	File Server	Win 2003 R2	Dell Poweredge 2950	8/7	10.134.1.3	9.0
Ahsstudent	AHS	File Server	Win 2003 R2	Dell Poweredge 2950	8/7	10.134.1.2	9.0
Ahs10	AHS	Domain Controller AHS	Win 2008 R2	Dell Poweredge 2950	7/17	10.134.1.10	9.0
Ahs11	AHS	Domain Controller AHS	Win 2003 R2	Dell Poweredge 2950	7/17	10.134.1.11	9.0
Ahsapps	AHS	Application Server	Win 2003 R2	Dell Poweredge 2950	7/17	10.134.1.1	9.0
Pontem	AMESBUR	Pontem Cemetary Software	Win 2008 R2	HP Compaq 8000 PC	11/19	10.128.1.28	2.7
Thcvh1	AMESBUR	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	2/22	10.128.1.18	7.4
Patriotserver	AMESBUR	Patriot Personal Property Server	Win 2003 R2	Dell Poweredge SC1430	7/10	10.128.7.21	10.1
Thcvs5	AMESBUR	Hyper-V Cluster (Pair 3)	Win 2008 R2	Dell Poweredge R415	7/14	10.121.1.31	6.0
Thcvs6	AMESBUR	Hyper-V Cluster (Pair 3)	Win 2008 R2	Dell Poweredge R415	7/14	10.121.1.32	6.0
Thcvs3	AMESBUR	Hyper-V Cluster (Pair 2)	Win 2008 R2	Dell Poweredge 2970	10/28	10.121.1.7	6.8
Thcvs4	AMESBUR	Hyper-V Cluster (Pair 2)	Win 2008 R2	Dell Poweredge 2970	10/28	10.121.1.8	6.8
Thcvs1	AMESBUR	Hyper-V Cluster (Pair 1)	Win 2008 R2	Dell Poweredge 1950	6/5	10.121.1.5	9.2
Thcvs2	AMESBUR	Hyper-V Cluster (Pair 1)	Win 2008 R2	Dell Poweredge 1950	5/21	10.121.1.6	9.2
Agr1	AMESBUR	Domain Controller AMESBURYGOV	Win 2003	Dell Poweredge 1750	2/1	10.121.1.1	13.5
Asdvh4	AMS	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	1/11	10.129.1.24	6.6
Ams3	AMS	File Server	Win 2003	Dell Poweredge 2800	3/14	10.129.1.23	9.4
Aps2	APS	Domain Controller APS/IMC	Win 2003	Dell Poweredge 2800	3/11	10.128.1.17	9.4
Asdvh3	CENTRAL	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	1/11	10.133.1.5	6.6
Central2	CENTRAL	Domain Controller CENTRAL	Win 2003	Dell Poweredge 2850	9/12	10.133.1.3	11.9
Asdvh5	CES	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	1/11	10.130.1.5	6.6

Physical Server Operating System Summary

Name	Domain	Function	OS Version	Model	Build Date	IP Address	Age (years)
Aes2	AES	Domain Controller AES	Win 2003	Dell Poweredge 1800	10/21	10.131.1.2	12.8
Ahsvideo1	AHS	Video Server	Win 2003	Dell Poweredge 1950	10/9	10.134.100	7.8
Agr1	AMESBURYGOV	Domain Controller AMESBURYGOV	Win 2003	Dell Poweredge 1750	2/1	10.121.1.1	13.5
Ams3	AMS	File Server	Win 2003	Dell Poweredge 2800	3/14	10.129.1.239	9.4
Aps2	APS	Domain Controller APS/IMC	Win 2003	Dell Poweredge 2800	3/11	10.128.1.17	9.4
Central2	CENTRAL	Domain Controller CENTRAL	Win 2003	Dell Poweredge 2850	9/12	10.133.1.3	11.9
Ahsvideo2	AHS	Video Server	Win 2003 R2	Dell Poweredge 1950	11/11	10.134.1.101	8.7
Ahsstaff	AHS	File Server	Win 2003 R2	Dell Poweredge 2950	8/7	10.134.1.3	9.0
Ahsstudent	AHS	File Server	Win 2003 R2	Dell Poweredge 2950	8/7	10.134.1.2	9.0
Ahs11	AHS	Domain Controller AHS	Win 2003 R2	Dell Poweredge 2950	7/17	10.134.1.11	9.0
Ahsapps	AHS	Application Server	Win 2003 R2	Dell Poweredge 2950	7/17	10.134.1.1	9.0
Patriotserver	AMESBURY	Patriot Personal Property Server	Win 2003 R2	Dell Poweredge SC1430	7/10	10.128.7.21	10.1
Asdvh2	AES	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	1/11	10.131.121	6.6
Asdvh1	AHS	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	1/11	10.134.1.20	6.6
Ahs10	AHS	Domain Controller AHS	Win 2008 R2	Dell Poweredge 2950	7/17	10.134.1.10	9.0
Pontem	AMESBURY	Pontem Cemetary Software	Win 2008 R2	HP Compaq 8000 PC	11/19	10.128.1.28	2.7
Thcvh1	AMESBURY	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	2/22	10.128.1.18	7.4
Thcvs5	AMESBURYGOV	Hyper-V Cluster (Pair 3)	Win 2008 R2	Dell Poweredge R415	7/14	10.121.1.31	6.0
Thcvs6	AMESBURYGOV	Hyper-V Cluster (Pair 3)	Win 2008 R2	Dell Poweredge R415	7/14	10.121.1.32	6.0
Thcvs3	AMESBURYGOV	Hyper-V Cluster (Pair 2)	Win 2008 R2	Dell Poweredge 2970	10/28	10.121.1.7	6.8
Thcvs4	AMESBURYGOV	Hyper-V Cluster (Pair 2)	Win 2008 R2	Dell Poweredge 2970	10/28	10.121.1.8	6.8
Thcvs1	AMESBURYGOV	Hyper-V Cluster (Pair 1)	Win 2008 R2	Dell Poweredge 1950	6/5	10.121.1.5	9.2
Thcvs2	AMESBURYGOV	Hyper-V Cluster (Pair 1)	Win 2008 R2	Dell Poweredge 1950	5/21	10.121.1.6	9.2
Asdvh4	AMS	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	1/11	10.129.1.241	6.6
Asdvh3	CENTRAL	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	1/11	10.133.1.5	6.6
Asdvh5	CES	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	1/11	10.130.1.5	6.6

Physical Server Function Summary

Name	Domain	Location	Function	OS Version	Model	Age (years)
Ahsapps	AHS	AHS	Application Server	Win 2003 R2	Dell Poweredge 2950	9.04
Aes2	AES	AES	Domain Controller AES	Win 2003	Dell Poweredge 1800	12.78
Ahs10	AHS	AHS	Domain Controller AHS	Win 2008 R2	Dell Poweredge 2950	9.04
Ahs11	AHS	AHS	Domain Controller AHS	Win 2003 R2	Dell Poweredge 2950	9.04
Agr1	AMESBURYGOV	AHS	Domain Controller AMESBURYGOV	Win 2003	Dell Poweredge 1750	13.50
Aps2	APS	APS	Domain Controller APS/IMC	Win 2003	Dell Poweredge 2800	9.39
Central2	CENTRAL	CENTRAL	Domain Controller CENTRAL	Win 2003	Dell Poweredge 2850	11.89
Ahsstaff	AHS	AHS	File Server	Win 2003 R2	Dell Poweredge 2950	8.98
Ahsstudent	AHS	AHS	File Server	Win 2003 R2	Dell Poweredge 2950	8.98
Ams3	AMS	AMS	File Server	Win 2003	Dell Poweredge 2800	9.38
Thcvs1	AMESBURYGOV	AHS	Hyper-V Cluster (Pair 1)	Win 2008 R2	Dell Poweredge 1950	9.16
Thcvs2	AMESBURYGOV	AHS	Hyper-V Cluster (Pair 1)	Win 2008 R2	Dell Poweredge 1950	9.20
Thcvs3	AMESBURYGOV	AHS	Hyper-V Cluster (Pair 2)	Win 2008 R2	Dell Poweredge 2970	6.76
Thcvs4	AMESBURYGOV	AHS	Hyper-V Cluster (Pair 2)	Win 2008 R2	Dell Poweredge 2970	6.76
Thcvs5	AMESBURYGOV	AHS	Hyper-V Cluster (Pair 3)	Win 2008 R2	Dell Poweredge R415	6.05
Thcvs6	AMESBURYGOV	AHS	Hyper-V Cluster (Pair 3)	Win 2008 R2	Dell Poweredge R415	6.05
Asdvh2	AES	AES	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	6.55
Asdvh4	AMS	AMS	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	6.55
Asdvh3	CENTRAL	CENTRAL	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	6.55
Asdvh5	CES	CES	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	6.55
Asdvh1	AHS	AHS	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	6.55
Thcvh1	AMESBURY	ACH	Hyper-V Host	Win 2008 R2	Dell Poweredge R210	7.44
Patriotserver	AMESBURY	ACH	Patriot Personal Property Server	Win 2003 R2	Dell Poweredge SC1430	10.06
Pontem	AMESBURY	ACH	Pontem Cemetary Software	Win 2008 R2	HP Compaq 8000 PC	2.70
Ahsvideo1	AHS	AHS	Video Server	Win 2003	Dell Poweredge 1950	7.81
Ahsvideo2	AHS	AHS	Video Server	Win 2003 R2	Dell Poweredge 1950	8.72

Virtual Server Summary

Name	Domain	Location	Function	OS Version	Host	IP	Cluster Strg
Aps3	APS	ACH	Domain Controller APS	Win 2003 R2	THCVH1	10.121.1.19	N/A
Thcdc	AMESBURY	ACH	Domain Controller THC	Win 2003 R2	THCVH1	10.121.1.9	N/A
Aes3	AES	AES	File Server	Win 2008 R2	ASDVH2	10.131.1.3	N/A
Aes4	AES	AES	File Server	Win 2008 R2	ASDVH2	10.131.1.4	N/A
Aesdc1	AES	AES	Domain Controller AES	Win 2008 R2	ASDVH2	10.131.1.1	N/A
Agr2	AMESBURYGOV	AHS	Domain Controller AMESBURYGOV	Win 2008 R2	AHSCluster	10.121.1.24	EMC
Agr3	AMESBURYGOV	AHS	Domain Controller AMESBURYGOV	Win 2008 R2	AHSCluster	10.121.1.25	EMC
Ames-wsus	AMESBURYGOV	AHS	Windows Update Server	Win 2012 R2	AHSCluster	10.121.1.3	EMC
Asd-vipre	AMESBURYGOV	AHS	Vipre Anti Virus Server	Win 2008 R2	THCVS2	10.121.1.36	N/A
Bes	AMESBURYGOV	AHS	Application Server - Blackberry Enterprise	Win 2008 R2	THCVS5	10.121.1.29	N/A
Ftd10	AMESBURYGOV	AHS	Exchange 2010 Server	Win 2008 R2	AHSCluster	10.131.1.26	Hitachi
Help-desk	AMESBURYGOV	AHS	Application Server - Help Desk	Win 2008 R2	AHSCluster	10.131.1.44	EMC
Munis	AMESBURYGOV	AHS	Application Server - Munis	Win 2012 R2	THCVS3	10.121.1.38	N/A
Thc-av	AMESBURYGOV	AHS	Kaspersky AV Server	Win 2012 R2	AHSCluster	10.121.1.43	EMC
Thc3	AMESBURY	AHS	Application Server	Win 2003 R2	AHSCluster	10.121.1.16	EMC
Thcbackup	AMESBURY	AHS	Backup Assist Server	Win 2008 R2	AHSCluster	10.121.1.13	Hitachi
Thcbackup12	AMESBURY	AHS	Backup Exec Server	Win 2008 R2	AHSCluster	10.121.1.35	EMC
Thccad	AMESBURY	AHS	Application Server	Win 2008 R2	AHSCluster	10.121.1.34	Hitachi
Thcdc1	AMESBURY	AHS	Domain Controller THC	Win 2008 R2	AHSCluster	10.121.1.30	Hitachi
Thcdc2	AMESBURY	AHS	Domain Controller THC	Win 2008 R2	AHSCluster	10.121.1.33	EMC
Thcfs	AMESBURY	AHS	File Server	Win 2008 R2	AHSCluster	10.121.1.12	Hitachi
Thcvis	AMESBURY	AHS	Application Server - Vision Govt Solutions	Win 2008	AHSCluster	10.121.1.19	Hitachi
Aesdc0	AES	AHS	Domain Controller AES	Win 2008 R2	ASDVH1	10.134.10.131	N/A
Ahs-lic	AHS	AHS	Adobe License Manager	Win 2008 R2	ASDVH1	10.134.1.12	N/A
Ahsdc0	AHS	AHS	Domain Controller AHS	Win 2008 R2	ASDVH1	10.134.10.134	N/A
Ahsdc1	AHS	AHS	Domain Controller AHS	Win 2012 R2	ASDVH1	10.134.10.136	N/A
Amsdc0	AMS	AHS	Domain Controller AMS	Win 2008 R2	ASDVH1	10.134.10.132	N/A
Centraldc0	CENTRAL	AHS	Domain Controller Central	Win 2008 R2	ASDVH1	10.134.10.133	N/A
Cesdc0	CES	AHS	Domain Controller CES	Win 2008 R2	ASDVH1	10.134.10.135	N/A
Ams1	AMS	AMS	File Server	Win 2008 R2	ASDVH4	10.129.1.243	N/A
Ams5	AMS	AMS	File Server	Win 2008 R2	ASDVH4	10.129.1.245	N/A
Amsapps1	AMS	AMS	Application Server	Win 2008 R2	ASDVH4	10.129.1.246	N/A
Amsdc1	AMS	AMS	Domain Controller AMS	Win 2008 R2	ASDVH4	10.129.1.242	N/A
Central-nkds	CENTRAL	CENTRAL	Application Server - Nutrikids	Win 2012 R2	AHSVH3	10.133.1.9	N/A
Central4	CENTRAL	CENTRAL	File Server	Win 2008 R2	AHSVH3	10.133.1.7	N/A
Central5	CENTRAL	CENTRAL	File Server	Win 2008 R2	AHSVH3	10.133.1.8	N/A
Centraldc1	CENTRAL	CENTRAL	Domain Controller Central	Win 2008 R2	ASDVH3	10.133.1.6	N/A
Ces3	CES	CES	Application Server	Win 2008 R2	ASDVH5	10.130.1.7	N/A
Ces4	CES	CES	File Server	Win 2008 R2	ASDVH5	10.130.1.10	N/A
Ces5	CES	CES	File Server	Win 2008 R2	ASDVH5	10.130.1.5	N/A
Cesdc1	CES	CES	Domain Controller CES	Win 2008 R2	ASDVH5	10.130.1.3	N/A

Virtual Server Function Summary

Name	Domain	Location	Function	OS Version	Host	IP	Cluster Strg
Ahs-lic	AHS	AHS	Adobe License Manager	Win 2008 R2	ASDVH1	10.134.1.12	N/A
Thc3	AMESBURY	AHS	Application Server	Win 2003 R2	AHSCluster	10.121.1.16	EMC
Thccad	AMESBURY	AHS	Application Server	Win 2008 R2	AHSCluster	10.121.1.34	Hitachi
Amsapps1	AMS	AMS	Application Server	Win 2008 R2	ASDVH4	10.129.1.246	N/A
Ces3	CES	CES	Application Server	Win 2008 R2	ASDVH5	10.130.1.7	N/A
Bes	AMESBURYGOV	AHS	Application Server - Blackberry Enterprise	Win 2008 R2	THCVS5	10.121.1.29	N/A
Help-desk	AMESBURYGOV	AHS	Application Server - Help Desk	Win 2008 R2	AHSCluster	10.131.1.44	EMC
Munis	AMESBURYGOV	AHS	Application Server - Munis	Win 2012 R2	THCVS3	10.121.1.38	N/A
Central-nkds	CENTRAL	CENTRAL	Application Server - Nutrikids	Win 2012 R2	AHSVH3	10.133.1.9	N/A
Thcvis	AMESBURY	AHS	Application Server - Vision Govt Solutions	Win 2008	AHSCluster	10.121.1.19	Hitachi
Thcbackup	AMESBURY	AHS	Backup Assist Server	Win 2008 R2	AHSCluster	10.121.1.13	Hitachi
Thcbackup12	AMESBURY	AHS	Backup Exec Server	Win 2008 R2	AHSCluster	10.121.1.35	EMC
Aesdc1	AES	AES	Domain Controller AES	Win 2008 R2	ASDVH2	10.131.1.1	N/A
Aesdc0	AES	AHS	Domain Controller AES	Win 2008 R2	ASDVH1	10.134.10.131	N/A
Ahsdc0	AHS	AHS	Domain Controller AHS	Win 2008 R2	ASDVH1	10.134.10.134	N/A
Ahsdc1	AHS	AHS	Domain Controller AHS	Win 2012 R2	ASDVH1	10.134.10.136	N/A
Agr2	AMESBURYGOV	AHS	Domain Controller AMESBURYGOV	Win 2008 R2	AHSCluster	10.121.1.24	EMC
Agr3	AMESBURYGOV	AHS	Domain Controller AMESBURYGOV	Win 2008 R2	AHSCluster	10.121.1.25	EMC
Amsdc0	AMS	AHS	Domain Controller AMS	Win 2008 R2	ASDVH1	10.134.10.132	N/A
Amsdc1	AMS	AMS	Domain Controller AMS	Win 2008 R2	ASDVH4	10.129.1.242	N/A
Aps3	APS	ACH	Domain Controller APS	Win 2003 R2	THCVH1	10.121.1.19	N/A
Centraldc0	CENTRAL	AHS	Domain Controller Central	Win 2008 R2	ASDVH1	10.134.10.133	N/A
Centraldc1	CENTRAL	CENTRAL	Domain Controller Central	Win 2008 R2	ASDVH3	10.133.1.6	N/A
Cesdc0	CES	AHS	Domain Controller CES	Win 2008 R2	ASDVH1	10.134.10.135	N/A
Cesdc1	CES	CES	Domain Controller CES	Win 2008 R2	ASDVH5	10.130.1.3	N/A
Thcdc	AMESBURY	ACH	Domain Controller THC	Win 2003 R2	THCVH1	10.121.1.9	N/A
Thcdc1	AMESBURY	AHS	Domain Controller THC	Win 2008 R2	AHSCluster	10.121.1.30	Hitachi
Thcdc2	AMESBURY	AHS	Domain Controller THC	Win 2008 R2	AHSCluster	10.121.1.33	EMC
Ftd10	AMESBURYGOV	AHS	Exchange 2010 Server	Win 2008 R2	AHSCluster	10.131.1.26	Hitachi
Aes3	AES	AES	File Server	Win 2008 R2	ASDVH2	10.131.1.3	N/A
Aes4	AES	AES	File Server	Win 2008 R2	ASDVH2	10.131.1.4	N/A
Thcfs	AMESBURY	AHS	File Server	Win 2008 R2	AHSCluster	10.121.1.12	Hitachi
Ams1	AMS	AMS	File Server	Win 2008 R2	ASDVH4	10.129.1.243	N/A
Ams5	AMS	AMS	File Server	Win 2008 R2	ASDVH4	10.129.1.245	N/A
Central4	CENTRAL	CENTRAL	File Server	Win 2008 R2	AHSVH3	10.133.1.7	N/A
Central5	CENTRAL	CENTRAL	File Server	Win 2008 R2	AHSVH3	10.133.1.8	N/A
Ces4	CES	CES	File Server	Win 2008 R2	ASDVH5	10.130.1.10	N/A
Ces5	CES	CES	File Server	Win 2008 R2	ASDVH5	10.130.1.5	N/A
Thc-av	AMESBURYGOV	AHS	Kaspersky AV Server	Win 2012 R2	AHSCluster	10.121.1.43	EMC
Asd-vipre	AMESBURYGOV	AHS	Vipre Anti Virus Server	Win 2008 R2	THCVS2	10.121.1.36	N/A
Ames-wsus	AMESBURYGOV	AHS	Windows Update Server	Win 2012 R2	AHSCluster	10.121.1.3	EMC

Virtual Server Operating System Summary

Name	Domain	Location	Function	OS Version	Host	IP	Cluster Strg
Aps3	APS	ACH	Domain Controller APS	Win 2003 R2	THCVH1	10.121.1.19	N/A
Thcdc	AMESBURY	ACH	Domain Controller THC	Win 2003 R2	THCVH1	10.121.1.9	N/A
Thc3	AMESBURY	AHS	Application Server	Win 2003 R2	AHSCluster	10.121.1.16	EMC
Thcvis	AMESBURY	AHS	Application Server - Vision Govt Solutions	Win 2008	AHSCluster	10.121.1.19	Hitachi
Aes3	AES	AES	File Server	Win 2008 R2	ASDVH2	10.131.1.3	N/A
Aes4	AES	AES	File Server	Win 2008 R2	ASDVH2	10.131.1.4	N/A
Aesdc1	AES	AES	Domain Controller AES	Win 2008 R2	ASDVH2	10.131.1.1	N/A
Agr2	AMESBURYGOV	AHS	Domain Controller AMESBURYGOV	Win 2008 R2	AHSCluster	10.121.1.24	EMC
Agr3	AMESBURYGOV	AHS	Domain Controller AMESBURYGOV	Win 2008 R2	AHSCluster	10.121.1.25	EMC
Asd-vipre	AMESBURYGOV	AHS	Vipre Anti Virus Server	Win 2008 R2	THCVS2	10.121.1.36	N/A
Bes	AMESBURYGOV	AHS	Application Server - Blackberry Enterprise	Win 2008 R2	THCVS5	10.121.1.29	N/A
Ftd10	AMESBURYGOV	AHS	Exchange 2010 Server	Win 2008 R2	AHSCluster	10.131.1.26	Hitachi
Help-desk	AMESBURYGOV	AHS	Application Server - Help Desk	Win 2008 R2	AHSCluster	10.131.1.44	EMC
Thcbackup	AMESBURY	AHS	Backup Assist Server	Win 2008 R2	AHSCluster	10.121.1.13	Hitachi
Thcbackup12	AMESBURY	AHS	Backup Exec Server	Win 2008 R2	AHSCluster	10.121.1.35	EMC
Thccad	AMESBURY	AHS	Application Server	Win 2008 R2	AHSCluster	10.121.1.34	Hitachi
Thcdc1	AMESBURY	AHS	Domain Controller THC	Win 2008 R2	AHSCluster	10.121.1.30	Hitachi
Thcdc2	AMESBURY	AHS	Domain Controller THC	Win 2008 R2	AHSCluster	10.121.1.33	EMC
Thcfs	AMESBURY	AHS	File Server	Win 2008 R2	AHSCluster	10.121.1.12	Hitachi
Aesdc0	AES	AHS	Domain Controller AES	Win 2008 R2	ASDVH1	10.134.10.131	N/A
Ahs-lic	AHS	AHS	Adobe License Manager	Win 2008 R2	ASDVH1	10.134.1.12	N/A
Ahsdc0	AHS	AHS	Domain Controller AHS	Win 2008 R2	ASDVH1	10.134.10.134	N/A
Amsdc0	AMS	AHS	Domain Controller AMS	Win 2008 R2	ASDVH1	10.134.10.132	N/A
Centraldc0	CENTRAL	AHS	Domain Controller Central	Win 2008 R2	ASDVH1	10.134.10.133	N/A
Cesdc0	CES	AHS	Domain Controller CES	Win 2008 R2	ASDVH1	10.134.10.135	N/A
Ams1	AMS	AMS	File Server	Win 2008 R2	ASDVH4	10.129.1.243	N/A
Ams5	AMS	AMS	File Server	Win 2008 R2	ASDVH4	10.129.1.245	N/A
Amsapps1	AMS	AMS	Application Server	Win 2008 R2	ASDVH4	10.129.1.246	N/A
Amsdc1	AMS	AMS	Domain Controller AMS	Win 2008 R2	ASDVH4	10.129.1.242	N/A
Central4	CENTRAL	CENTRAL	File Server	Win 2008 R2	AHSVH3	10.133.1.7	N/A
Central5	CENTRAL	CENTRAL	File Server	Win 2008 R2	AHSVH3	10.133.1.8	N/A
Centraldc1	CENTRAL	CENTRAL	Domain Controller Central	Win 2008 R2	ASDVH3	10.133.1.6	N/A
Ces3	CES	CES	Application Server	Win 2008 R2	ASDVH5	10.130.1.7	N/A
Ces4	CES	CES	File Server	Win 2008 R2	ASDVH5	10.130.1.10	N/A
Ces5	CES	CES	File Server	Win 2008 R2	ASDVH5	10.130.1.5	N/A
Cesdc1	CES	CES	Domain Controller CES	Win 2008 R2	ASDVH5	10.130.1.3	N/A
Ames-wsus	AMESBURYGOV	AHS	Windows Update Server	Win 2012 R2	AHSCluster	10.121.1.3	EMC
Munis	AMESBURYGOV	AHS	Application Server - Munis	Win 2012 R2	THCVS3	10.121.1.38	N/A
Thc-av	AMESBURYGOV	AHS	Kaspersky AV Server	Win 2012 R2	AHSCluster	10.121.1.43	EMC
Ahsdc1	AHS	AHS	Domain Controller AHS	Win 2012 R2	ASDVH1	10.134.10.136	N/A
Central-nkds	CENTRAL	CENTRAL	Application Server - Nutrikids	Win 2012 R2	AHSVH3	10.133.1.9	N/A

Storage

There are currently four large storage devices housed in the AHS data center. Two are used to support the clustering of Hyper-V hosts and two are used for backup.

The oldest device is a Hitachi SMS-100. The unit in place has 9TB of disk space configured as a RAID 6 array. (RAID 6 arrays can survive two drive failures. A third drive failure will cause the array to fail). It has dual iScsi (network based) controllers and dual power supplies. Its cost in 2009 was approximately $15k. It has an unusual design. It is highly engineered and has top quality components. It uses the same mechanisms and software that Hitachi's $100K storage arrays used. End of service (support) for the SMS occurred in June 2013. Part of the unusual design of this product is that it contains no field replicable parts. The power supplies, controllers and hard drives are fixed and not removable. This kept the manufacturing costs low and the quality high, but presented maintenance issues. In the event of a hard drive failure, a new drive can be inserted into one of two slots on the front of the unit. The controllers will disable the failed hard drive and begin to use the new drive as part of the array. If a controller, power supply or more than two hard drives fail, Hitachi would swap out the entire unit. The old unit and new unit are connected and the data from the older unit is transferred to the newer unit. The old array was then returned to Hitachi for factory repair.

The SMS-100 is currently supporting Hyper-V clustering and is providing storage for 6 virtual machines, including the Email server.

There is a newly purchased EMC VNXe3200 storage array which is also being used to support the Hyper-V cluster. This is a modern, current, high quality storage array. It has two drive pools both 7TB. One is a RAID 6 array consisting of high speed drives, the other a RAID 5 array (RAID 5 can only survive a single drive failure) consisting of slower but larger drives. This drive configuration is typical of the smaller EMC storage arrays. The software that operates the array is present on the first array. It also is using iScsi network connections to connect to the cluster hosts.

There are two drive arrays are used solely to store backups.

A Netgear ReadyNAS 2100 with 6TB of space (RAID 5) is connected to the THCBackup server. This server is running "BackupAssist" software. This is an inexpensive but highly functional file based backup solution. It creates easy to use historical file backups. It utilizes Microsoft "single instance store" technology that allows highly efficient and compact storage optimization yielding coherent and easy to use historical backups. Using this technology enables the retention of a large number of time-related data snapshots. Please refer to the image below for a list of the servers utilizing this backup procedure.

An Enhance RS16IP4-V3 storage array with 27TB of space is connected to the THCBackup12 server. This server is running "Backup Exec 2015" software. This is an industry standard backup package produced by Veritas. Veritas was purchased by Symantec in 2004 for $13.5B and then sold to an investor group in 2015 for $8B. This group resurrected the Veritas name and they now supply and support the Backup Exec products (the current version is Backup Exec 2016). This software is capable of creating operating system level backups of both physical and virtual servers as well as application servers.This is the server

that is performing all of the structured backups (e.g. Exchange) Please refer to the image below for a list of the servers utilizing this backup procedure.

Recommendations

The Hitachi array should be retired. This could dovetail with our recommendation of moving away from Hyper-V clustering, the servers currently being housed on the Hitachi being targeted as the first to be moved to new servers. An alternative solution would be to move the Hitachi based servers to an expanded EMC storage array. But we believe the costs to expand the EMC would be better used to purchase new servers.

We would also recommend the replacement of the Netgear ReadyNas as it is no longer being supported. There are numerous low cost storage arrays currently available, and purchasing a newer larger array could allow more historical data to be saved. If a complete migration away from Hyper-V clustering is implemented, the EMC could be used for backups replacing the Netgear.

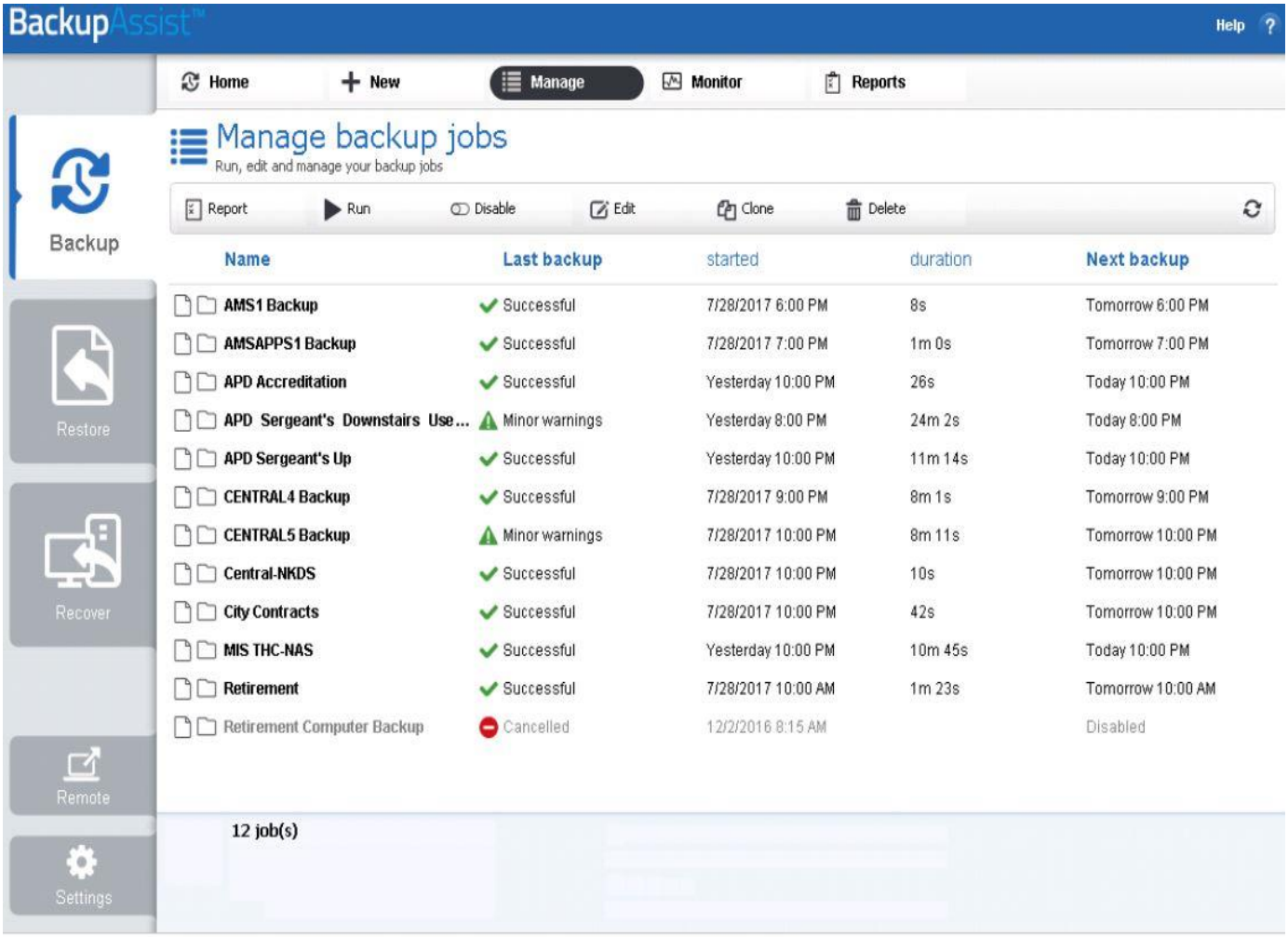
The EMC and Enhance arrays are still within their support windows and useful lifetime and should be retained.

The backups for servers that are located in the high school datacenter are stored on storage arrays that also reside there. An unforeseen disaster occurring in that datacenter would cause a total data loss. We would recommend that these backups be geographically separated from their original data source locations. The recent WAN backbone upgrade makes this feasible from a networking standpoint. Building a datacenter in city hall would give you a good location for this second backup location.

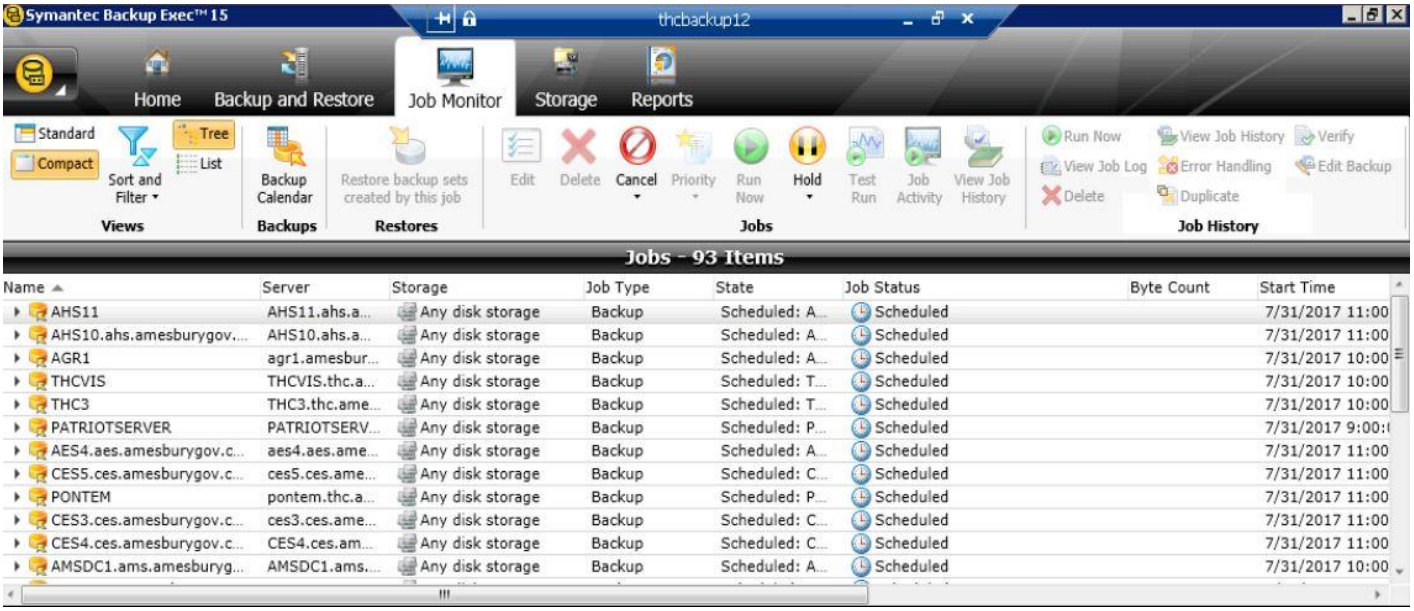
Storage Array Hardware Summary

Device	Location	IP	Purpose	Capacity	RAID Level	Date Aquired	Age (years)
Hitach SMS 100	AHS	10.121.0.20	HyperV Cluster Shared Storage	9TB	RAID 6	2009	8
EMC VNXe5200	AHS	10.121.1.10	HyperV Cluster Shared Storage	7TB/7TB	RAID 5/6	2016	1
Enhance RS16IP4-V3	AHS	10.121.1.23	Backup	27TB	RAID 5	2012	5
Netgear ReadyNas 2100	AHS	10.121.0.13	Backup	6TB	RAID 5	2010	7

BackupAssist Job Summary



BackupExec Job Summaries



Workstations

The overall count of workstations in both the municipal and school settings is 924.

There are 85 workstations in municipal buildings and 27 in the public safety buildings. There are 23 running Windows 10, 2 running Windows 8.1, 79 running Windows 7 and 8 running Windows XP.

The schools contain 812 workstations, 39 are running Windows 10, 694 are running Windows 7 and 90 are running Windows XP.

Recommendations

Within the municipal offices workstations are typically used by one person, or at most a small number of people. In a school setting, it's used by a teacher or a number of students. The status of workstations is not as important as that of the servers, since servers tend to be a resource shared by a large number of people.

There are cases where a workstation running an older operating system is required to support older applications. But in all other cases, having a newer workstation with a newer operating system tends to increase productivity. Moreover, having older operating systems software can sometimes be a security concern. Older operating systems were written when there were less security threats and before the threats were easily distributed over the Internet.

Physical age is also a concern; older computers are more likely to fail. Computers running Windows XP are at least 6 years old and could be almost 8 years old. Windows 7 computers are at least 2 years old and at most 6 years old. Windows 10 computers can be no more than 2 years old.

For these reasons, it's a good to have an upgrade cycle where a certain number of workstations are replaced every year. This is especially import in the municipal environment where worker productivity, data protection and security are vital. A five or six-year cycle is what we would recommend. Starting in year one with the replacement of the Windows XP computers. (A six-year cycle, without growth, would consists of 12 computers per year).

Replacing computers in the schools is a more complex matter. The computers used by administrators, staff and teachers should be upgraded on a regular basis for the reasons stated above.

The student computers tend to be less mission critical, though with the trend towards on-line learning as well as on-line testing, this is becoming less true. The number of computers involved makes the commitment to an upgrade cycle difficult.

Workstation Summary

Operating System	Windows 10	Windows 8.1	Windows 7	Windows XP	Total
City	22	1	55	7	85
Public Safety	1	1	24	1	27
Municipal Totals	23	2	79	8	112
AHS	25		293	1	319
AMS	7		231	24	262
CES	3		112	7	122
AES	1		42	42	85
Central	3		16	5	24
School Totals	39	0	694	79	812
Overall Totals	62	2	773	87	924
Year in Production	7/15-Now	10/13-7/15	10/13-10/11	10/11-10/09	
Maximum Age days	769	1407	2138	2868	
Maximum Age years	2.11	3.85	5.86	7.86	

Security and Data Protection

With the explosion of web and email usage, the likelihood of downloading or running some malicious software has become much more likely.

Sending email is basically free, so spammers can send out millions of emails loaded with well disguised exploits. If only a small number find an unsuspecting target the payout can be considerable. Most of these exploits originate from outside of the United States where netting US dollars can be quite lucrative.

Historically viruses were written and distributed by hackers whose only payment was the publicity they received documenting the damage done by their malicious code.

With the advent of non-traceable crypto-currencies, they have started to monetize their handiwork. There is great leverage provided by writing a small piece of code that can encrypt files and demand a fee for a decryption mechanism. These viruses have gotten more sophisticated and harder to detect and prevent. When large sums of money are involved people can become quite creative.

Having up to date and high quality anti-virus and anti-malware software is imperative. The city and schools are currently using the managed version of Kaspersky anti-virus. This is a well-regarded product and scores highly on most anti-virus comparisons.

The first line of defense against the internet hoards is your firewall. The Sophos products currently deployed are also of high-quality and provide good overall protection. Beside the normal isolation provided by the firewalling functionally it also has active anti-virus and intrusion-protection applications. Its anti-SPAM application attempts to filter out emails that range from annoying to malicious. File Filtering processes also attempts to remove virus infected attachments. Web filtering is also used to steer users away from suspicious sites.

But no matter how much protection you have, or how many layers of security are present, there is a chance you will be exposed to a new virus or exploit. These will not be recognized by the firewall or the anti-virus software, and your data will be at risk. The only fail-safe protection in these cases is to have a current data backup.

Backups are currently being done on two servers, using two different storage arrays and two different software strategies. These backups are being monitored on a daily basis and adjustments and corrections made where necessary. This is very good (and in our experience, unusual.)

This would seem to be sufficient, and a few years ago it would have been. But as the viruses and exploits become more sophisticated, they will find your backups and destroy them. They first go after the live data, and then the backups. If they leave backups intact, you are less likely to pay to retrieve your newly encrypted data.

It has become vital to have backups that are "off line", not accessible from your live network in any direct way.

Cloud based backup solutions can provide this type of isolation. However, sometimes having large files can limit the usefulness of this mechanism. For example, due to their size, it would be impossible to back up your exchange databases to anything other than local storage.

The strategy of how to accomplish this off-line backup strategy is beyond the scope of this report, but we can review some general backup related guidelines:

1) No data should ever be stored on the local computer; they are normally not backed up. These viruses almost always target data that is stored locally first.
2) Do not used mapped drives. This is low hanging fruit for almost all of the encryption viruses. Most of the older viruses will only encrypt network data exposed via mapped drives. The newer ones are doing more network scans and will attempt to encrypt files that aren't currently mapped.
3) Have historical backups. If you only have one backup it will likely be overwritten by encrypted files before anyone notices the infection.
4) Have backups that are unreachable by even the cleverest virus. Physically off-line backups are probably the best solution, but are also hard to manage.
5) Have multiple backups using different media and backup strategies.

This is the most important aspect of our recommendations. Backups protect against not only malevolent software but also hardware failure, and with older servers, this is even more of an imperative.

And finally, we would recommend that the school and municipal networks be logically separated.

Currently the city and public service networks are accessible from the school networks and vice versa, all network traffic is fully routable on the entire network. This puts municipal resources at risk.

This separation could be accomplished using either the existing firewall or by using access control mechanisms that are supported by the WAN switches. Due to the distributed nature of your network (e.g. the colocation of municipal and school servers at AHS) this task will be somewhat complex.

Since some network, server and backup management functions for both the municipal and school resources are done by common individuals, if there is a network separation, these tasks will also become more complex. Some functions might have to be done independently for each entity (e.g. backups).

This is an important consideration since both groups have data that would be considered private (e.g. pupil records and police records).

Email

Current Status

A single server running Microsoft Exchange 2010 currently provides email services. This server is running within the 2008R2 Hyper-V cluster housed at AHS. There are 701 user mailboxes present on this server. The total size of these mailboxes is 670GB, with 930GB of free space available for expansion. This server is also providing Email relaying services for other servers where required.

The breakdown of mailboxes is:

- Schools – 433
- City – 173
- Fire Department – 37
- Police Department – 58

A Barracuda BMA 450 Mail Archiver is being used for mail archiving and the Sophos firewall is performing SPAM filtering.

General support for Exchange 2010 ended at the start of 2015. Going forward Microsoft will only be releasing vital security updates for this product. These updates, as well as paid support will continue until the start of 2020.

A Veritas Backup Exec 2015 Server is performing nightly backups of the server as well as the information stores (Exchange email databases.)

Recommendations

The mail server, archiver and backup mechanisms are sufficient and working well. There is adequate capacity in all systems for current operations as well as future growth.

There are three options available options:

1) Retain the current version of Exchange.
2) Migrate to an on premise Exchange 2016 solution.
3) Migrate to a cloud based email solution.

Option 1 is certainly the simplest and most cost effective choice. There are currently no compatibility issues between Exchange 2010 and any version of Outlook (the office mail client, currently Outlook 2016). Most backup solutions, including the version currently being used, will remain compatible with Exchange 2010. There are no major features offered by the newer versions of Exchange (2013 and 2016) that would make upgrading a compelling option.

The main motivation for upgrading would be the eventual end of support in the year 2020, at which time, an upgrade or migration would be prudent.

If a decision is made to remain with Exchange 2010, a few changes would be in order. First, as part of a strategy of moving away from a clustered environment (see Virtualization) and upgrading the server base the virtual machine currently running the Exchange environment should be migrated to a newer and faster standalone Hyper-V host.

Another suggested modification would be to balance the information stores (mailbox databases) and reduce the size of each store to a maximum of 500GB. The running version of Exchange supports up to 4 mailbox stores. Making the stores smaller will increase overall performance, backup performance as well as reduce the amount of time it would take to repair or restore a corrupted database.

Option 2 is to migrate the Exchange 2010 mailboxes to an Exchange 2016 server. This would require the purchase of an Exchange 2016 Server license as well as a client licenses for each user. The costs of these licenses is complicated by the mixed use of this server, some users being academic and some being local government. Microsoft pricing is significantly lower for academic use and a mix of client licenses is allowed. The server license would probably not be academic-eligible.

The current backup software, Backup Exec 2015 will support Exchange 2016 if feature pack 2 is installed. The Barracuda archiver would remain compatible as would the SPAM filtering provided by the Sophos firewall.

Option 3 is to migrate to a cloud based mail solution. There are two suggested options: Microsoft's Office 365 and Google Gmail.

Both Gmail and Office 365 (mailboxes) are currently offered at no cost to academic users: administrators, staff, faculty and students.

There would be a yearly licensing cost for non-school, city employees with either Office 365 or Gmail.

It has been our experience that users of the Outlook client find the Gmail client insufficient and prefer to continue to use the Microsoft platform. Those that have been primarily using Outlook Web Access find Gmail adequate.

Another factor in the equation is that a Microsoft Office license can be bundled with an Office 365 mailbox bringing down the total cost of ownership.

A (non-academic) license for Office is approximately $350, non-recurring. The yearly license fee for an Office 365 mailbox and an Office license is $150 per year. The office upgrade cycle is normally 3 years, and the Office 365 license always allows an upgrade to the latest version. If one normally upgrades Office every three years, then the added cost for the mailbox is approximately $33 per year.

Cloud-based mail can be structured so that it is more available than the on premise solution. Normally to provide this functionality, servers are deployed to the Microsoft server cloud (Azure). The costs associated with these Azure based servers average around $1500 per year. Using these servers would allow mail to be accessed even if the city servers are down.

The existing Barracuda mail archiver is compatible with both the Microsoft Office 365 and Google Gmail solutions.

With the cloud based mail solutions on site backup is no longer required. Backups are performed by the cloud provider. Recovery of accidental user deleted email is handled using Outlook and server retention

mechanisms. Some organizations opt for a third party cloud based backup service that provides more restoration flexibility.

Deciding what to do with Email is a complicated problem. Upgrading to an on premise Exchange 2016 solution requires a large up front licensing cost, as well as a fair amount of migration effort.

Migrating to Office 365 also requires a fair amount of effort and consulting costs. But ongoing costs are spread out and deterministic.

Staying with Outlook 2010 is not a tenable long-term solution, but the costs are low.

Most of our customer that have chosen an Office 365 migration have timed it to coincide with an anticipated Office upgrade. For example, if the bulk of users are running Office 2010 and there is the desire to upgrade to Office 2016, migrating to Office 365 at that time actually spreads the Office upgrade costs and has the added advantage of moving mail to the cloud.

The current inventory of Office on city computers breaks down as follows:

a) Office Pro XP – 8 users
b) Office Pro 2003 – 38 users
c) Office Pro 2010 – 33 users
d) Office Std 2010 – 27 users
e) Office Pro 2013 – 6 users

The XP and 2003 users are certainly due for an upgrade. A mix of Office 365 mailbox licenses with and without office might make sense now or in the near future.

Email User Summary

Location	Mail Users
AES	89
AHS	84
AMS	98
Central	56
CES	106
City	173
APS Fire	37
APS PD	58
Total	701

Conclusion

When considering the state of an IT infrastructure one has to look at the logical as well as the physical state.

Logically, how are functions performed and how the systems are structured. We would say that logically Amesbury's IT mechanisms are good, probably better than most municipalities. By embracing server virtualization at an early date and constantly improving the internet, wide area networks and local area networks Amesbury has a good infrastructure base.

The major problems lie in the age of the existing server hardware. Most of the current servers are in need of replacement. The good news is that replacing them at this point will cost much less that it would have in the past. Server and storage pricing has declined in recent years and with the new features of Windows server software highly reliable systems can be built without additional complex and expensive hardware. Since most of the current vital servers are virtual, they can be easily moved to a new server base without any migration costs. Any older physical servers can also be virtualized using some of these newer features as well.

To prioritize our recommendations:

0) Find better ways to protect your data from malware and hardware failure
1) Update the physical servers and move away from Windows clustering
2) Build a datacenter at city hall and upgrade the connections to public service buildings
3) Isolate the school and municipal networks
4) Commit to a workstation upgrade cycle
5) Upgrade or migrate Email services